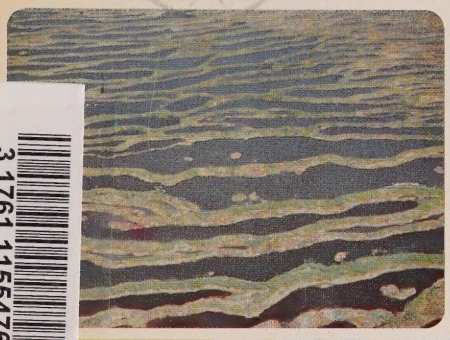
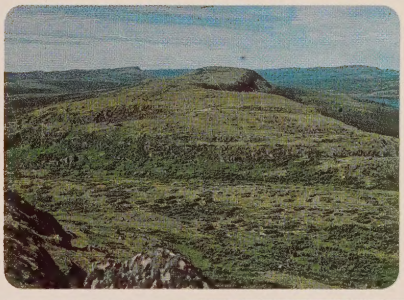
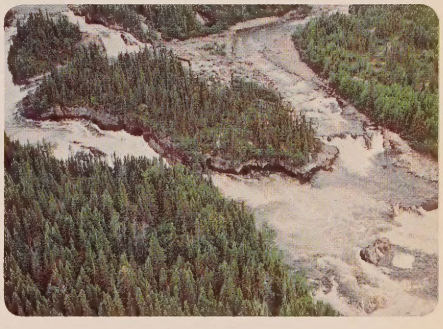
THE LAND SYSTEM
BASIC UNIT IN ECOLOGICAL MAPPING

SURVEY OF NATURAL RESOURCES IN THE JAMES BAY TERRITORY







Ecological Land Classification Series, N°. 8

THE LAND SYSTEM
BASIC UNIT IN ECOLOGICAL MAPPING

SURVEY OF NATURAL RESOURCES IN THE JAMES BAY TERRITORY

by J.P. DUCRUC
with the collaboration of Daniel Bērubē

Regional Ecological Studies Service
Environment Canada
Quebec City

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FOREWORD

This report is intended to provide an explanation of the mapping of the James Bay Territory and presupposes a knowledge of ecological mapping principles. It is written for a variety of users of ecological maps, and for this reason, although we develop a few theoretical concepts in detail, we have concentrated on the practical aspects of the mapping of the James Bay Territory.

ACKNOWLEDGMENTS

Ecological mapping at a scale of 1:125,000 of an area of 410,000 km^2 in three years requires teamwork. It is difficult to thank all those involved, but we would like to pay tribute here to all the photointerpreters and cartographers whose names are listed in Appendix II.

This report owes its present form to the many lively discussions with Michel Jurdant and Vincent Gerardin at the planning stage. And, without the infinite patience of Thérèse Labrecque, secretary, and Anne-Marie Thouret, draftswoman, the problems involved in illustrating and page-setting the report would have been unsurmountable.

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Chapter One

LAND SYSTEM

Definition

A land system is an area of land characterized by a particular pattern of landforms, surface geological materials, soils, vegetation chronosequences and waterbodies (Jurdant et al., 1977).

Readers often confuse land system and ecosystem. A strict definition of the difference between the two terms is outside the scope of this paper, however let us look at how the land system is evident in nature.

Hills (1961, 1976) uses the term 'landscape unit'. Vinogradov (1961) and Vinogradov et al., (1962) use the term 'landscape mapping', and Jurdant (1968) the term 'landscape type'. In the reader's mind, the notion of landscape is much more evocative of a geographical reality than the abstract notion of land system. While there may be a considerable subjective aspect to the notion of landscape, it can be based nonetheless on criteria that guarantee a degree of objectivity. The land system is a natural pattern of landscape features attached to a geographical framework comprising the permanent characteristics of an environment, such as its geology, relief, surficial materials, and waterbodies. Two separate land systems can be distinguished by the major boundaries between such characteristics.

Geographical framework and pattern

The definition of a land system is based on permanent elements of the environment that are related in terms of morphogenesis and geomorphology (Christian, 1959). Elements of the landscape are not distributed haphazardly in nature; their distribution is linked to a geographical framework, and each time the same geographical framework is found, the distribution of landscape elements is similar. A single type of geographical framework may recur in an area and with it, the same pattern of landscape elements. This orderly, predictable, and recurring combination of elements of the natural environment forms a pattern that is connected to a specific geographical framework.

In the scientific literature; the concepts of pattern, mosaic, and complex are too often confused. The first, as we have just explained, is the reflection of the genesis of a geographical reality, and so is orderly, recurrent and predictable. The others are merely convenient mapping terms. The distribution of the constituents of a mosaic or a complex is not genetically based, and is thus irregular, erratic and obviously not predictable. Failure to grasp this important distinction is the source of numerous misunderstandings and misconception about mapping units.

The notion of geographical framework and the concept of pattern can be illustrated by three simplified examples drawn from our ecological mapping of the James Bay Territory.

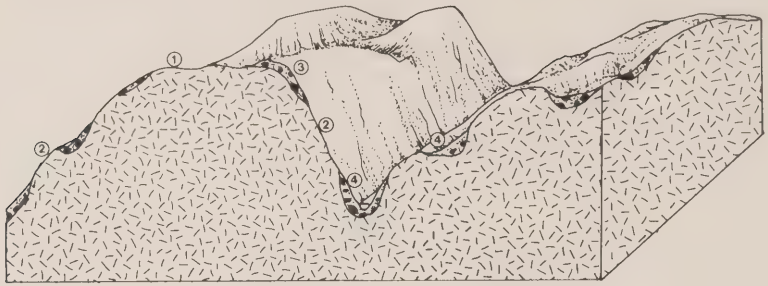

Figure 1 Diagram of a mountainous land system of the Canadian Shield

Example 1 (fig. 1)

Geographical framework: Mountainous land in the Canadian Shield, with a predominance of rocky outcrops and thin till.

Predictable distribution type (pattern) of landscape elements:

1 Convex summits: rocky outcrops; slopes of 0-5%, excessive to good drainage.
2 Steep slopes: rocky outcrops; slopes of 15-50%; excessive to good drainage.
3 Convex upper slopes: very thin till; slopes of 15-30%; good drainage with seepage.
4 Concave lower slopes: thin till; slopes of 15-30%; good drainage with seepage.

Thus the area in question is characterized by a pattern of:

- summits, steep slopes, convex upper slopes and concave lower slopes;
- rocky outcrops, very thin and thin till;
- excessive and good drainage and good drainage with seepage;
- gentle slopes, steep slopes and very steep slopes.

Example 2 (fig. 2)

Geographical framework: land with high hills in the Canadian Shield, with a predominance of thin till and thick till.

Predictable distribution type (pattern) of landscape elements:

1 Convex mid-slopes; thick till; slopes of 5-10%; good drainage.
2 Concave lower slopes; thick till; slopes of 15-30%; moderately good drainage with seepage.
3 Convex upper slopes; thin till, slopes of 15-30%; good drainage.
4 Concave upper slopes; thin till; slopes of 15-30%; good drainage with seepage.
5 Convex tops and upper slopes; very thin till, slopes of 0-10%; good drainage.
6 Steep tops and slopes; rocky outcrops; slopes of 0-30%; good drainage.

Figure 2 Diagram of a hilly land system of the Canadian Shield

Example 3 (fig. 3)

Geographical framework: Extremely eroded land in the marine deposits of the Tyrell Sea.

Predictable distribution type (pattern) of landscape elements:

1 Convex middle and upper slopes: marine clay; slopes of 15-30%; good to moderately good drainage.
2 Terraces and gentle slopes; marine clay slopes of 2-5%; imperfect drainage.
3 Banks of streams; recent alluvia; very gentle slopes of 0-5%; very poor drainage with seepage.

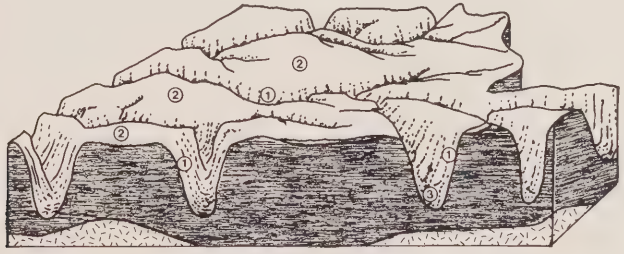

Figure 3 Diagram of a hilly ecological system in eroded marine clay

It is clear that when certain geographical conditions occur at the same time, the presence and combination of certain elements of the natural environment are predictable. It is also clear, however, that their proportions may vary within given limits. This means that separate land systems must be defined, even if they issue from a similar geographical framework. In the Canadian Shield, there are several types of mountainous landscapes with a predominance of rocky outcrops and thin till, and similary, there is some diversity in the eroded marine clay plain landscape.

Chapter Two

MAPPING LAND SYSTEMS

Representing land systems on maps

The ecological map of the James Bay Territory is a map of its land systems, as illustrated in the following detailed examples.

Example 1 (figs. 4 and 5)

EV-H1-5E-3-i44

Formulas are used on the ecological maps to identify characteristics of a land system (see Appendix 1 for details). Here is an explanation of the above sequence:

EV: The first two letters identify the land region[1] where the land system is located (EV: Lake Evans land region).

H1: Relief and thickness of surficial geological material (H: hilly relief; 1: thick surficial deposit, i.e. 1 metre or more above the bedrock).

5E: Type and morphology of dominant surficial deposits in the system (5: marine clay; E: eroded).

3: Index number of the land system, referring to the pattern of landscape elements, which is described and stored in a computerized file. The number gives acces to the file. In this example, it refers to the third H1-5E land system, i.e. the third land system with hilly relief and thick surficial deposits, dominated by eroded marine clay. These numbers are assigned for the whole of the James Bay Territory, not region by region. This may seem surprising, but in order to map land systems (mapping units only), knowledge of ecological regions (taxonomic or classificatory units) is not necessary.

For reasons of efficiency, land systems were mapped before the land regions were defined. This fact explains the numbering of the land systems, which were later associated with a specific land region.

i44: Type of waterbody and number of streams and wetlands (i: a large river with an average width of more than 60 m; 4: numerous streams, i.e. watercourses less than 20 m wide; 4: numerous wetlands sites, i.e. sites that are directly influenced by the proximity of a permanent or temporary watercourse.

For each formula on the ecological map there is a detailed descriptive card (fig. 6), which lists the land types[2] of each system and estimates the percentage of area of the entire system each occupies. Certain morphometric characteristics of waterbodies are also given:

1. We must stress how important knowledge of the land region is, for with this knowledge, boundaries can be established for an area within which relations between the renewable natural resource capability and the biophysical environment remain constant (Ducruc et al., 1976).

2. We will not elaborate on land types here. They are discussed in detail in a special report (Ducruc and Jurdant, 1979).

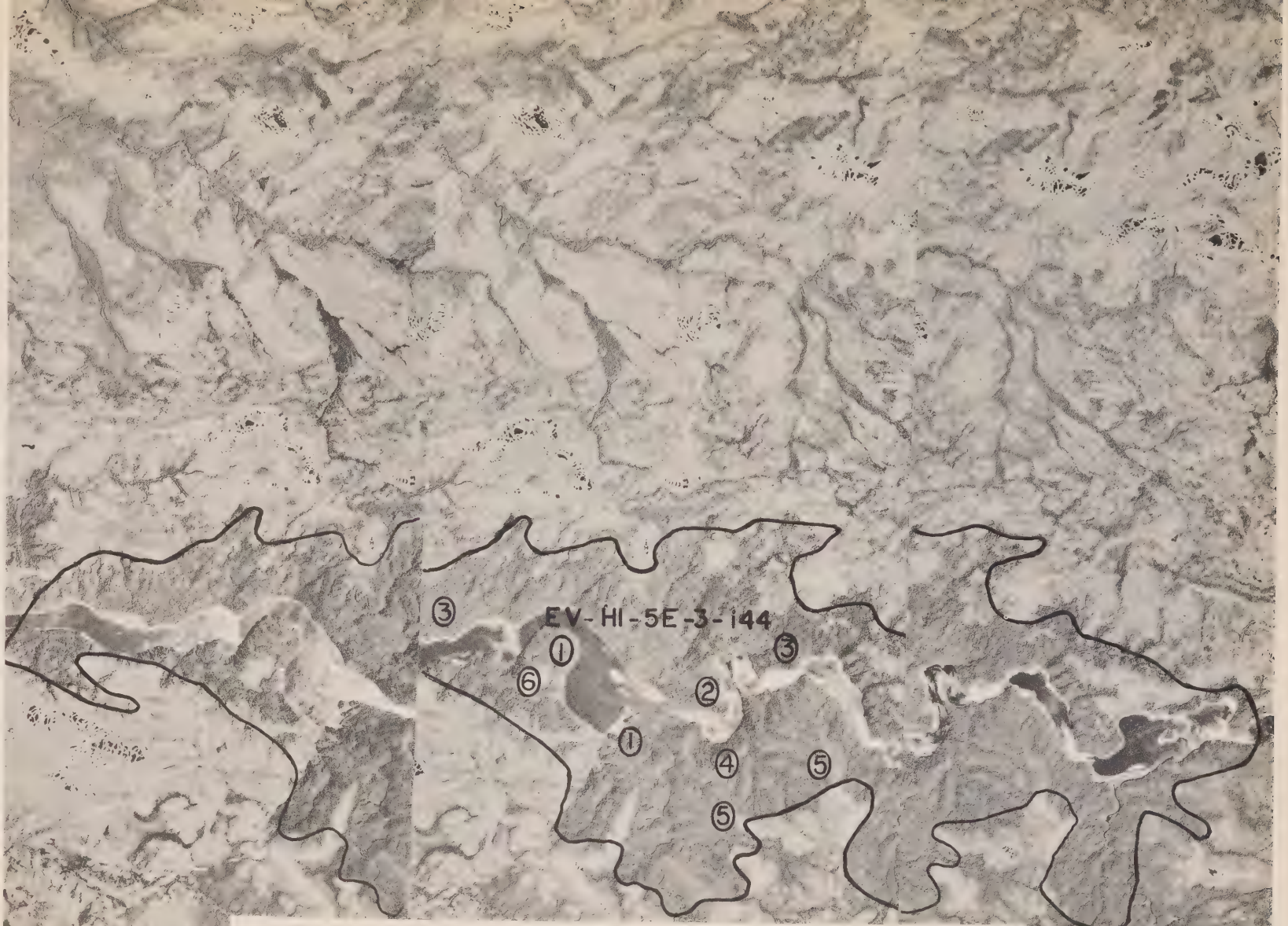

Figure 4.

STEREOGRAPH OF LAND SYSTEM EV-HI-5E-3-i44

(National Air Photograph Library, Ottawa. A-14973-127, 128, and 129; approximate scale 1:60,000.)

irregularity of the shoreline, slope of the littoral shelf (for lakes) or presence of rapids (for rivers), slope of banks, drainage system, depth and dominant geological material of the banks.

The information on the aquatic portion of the land system is coded as follows on the descriptive card (appendix 1):

2: meandering river course
3: numerous rapids
6: slopes of banks moderate and steep
1: deep river
5: banks made up mainly of marine clay

In this paper we show the cards as they are used in mapping. Some of the cards have blank columns. The columns are filled in only when the classification of taxonomic units is finished. Provisional land types are then given permanent status with the addition of the symbol of the land region in which the land system is located (e.g. MA23-EV instead of MA23). This symbol represents a specific soil type (sub-group of Canadian Soil Classification (CSSC, 1973) and a specific vegetation chronosequence (Ducruc and Jurdant, 1979).

Figure 5 Block diagram of land system EV-H1-3-i44
(The numbers on figures 4 and 5 refer to the ecological types listed on the card shown in fig. 6).

Reconnaissance n° 414	Photo n° 32N#201,202,203	LAND SYSTEM	Terrestrial portion EV-H1-5E-3
JBTE PROJECT			Aquatic portion i44-2361-5

Land type							
Provisional		Final	Landform	Drainage	Percentage	Soils	Vegetation
1	MA23		5a	23	10		
2	MA4		5a	4	10		
3	MA4*		5a	4*	50		
4	MA5*		5a	5*	15		
5	BAB6		7b/5a	6	5		
6	BN6		7a	6	10		

Figure 6 Descriptive card for land system

Example 2 (figs. 7 and 8)

NI-UI-2R2H-5-a12
b12
c12
f12
n12
h12

This land system is located in the Nichicun Lake land region (NI). Its relief is undulating (U); the surficial geological material is thick (1), of fluvioglacial origin (2), with ridges (R) and hummocks (H). It is the fifth land system (5) with this formula. There are very few streams (1) and wetland sites (2); it covers either partially or totally parcels of land with no bodies of water (a), small lakes (b and c), medium-size lakes (f), large lakes (n), and one river with an average width between 20 and 60 m (h).

The descriptive card (fig. 9) gives the remaining information on the morphometric characteristics of the waterbodies and on the distribution of land types.

This additional information is coded as followed:

- the shoreline of the small lakes (b and c) is irregular (2); the shoreline of the large lakes (f and n) is very irregular (3). The slope of the littoral shelf on all lakes is gentle (1). The slope of the shore of small lakes is gentle and moderate (2). The lakes are all closed and shallow (8) with beaches of fluvioglacial sand (2).
- the course of the river (h) is sinuous (1), with no rapids (1); the slope of its banks is moderate and gentle (4); the riverbed is shallow (2); and the banks are made up of fluvioglacial sand (2) and sandy alluvia (4*).

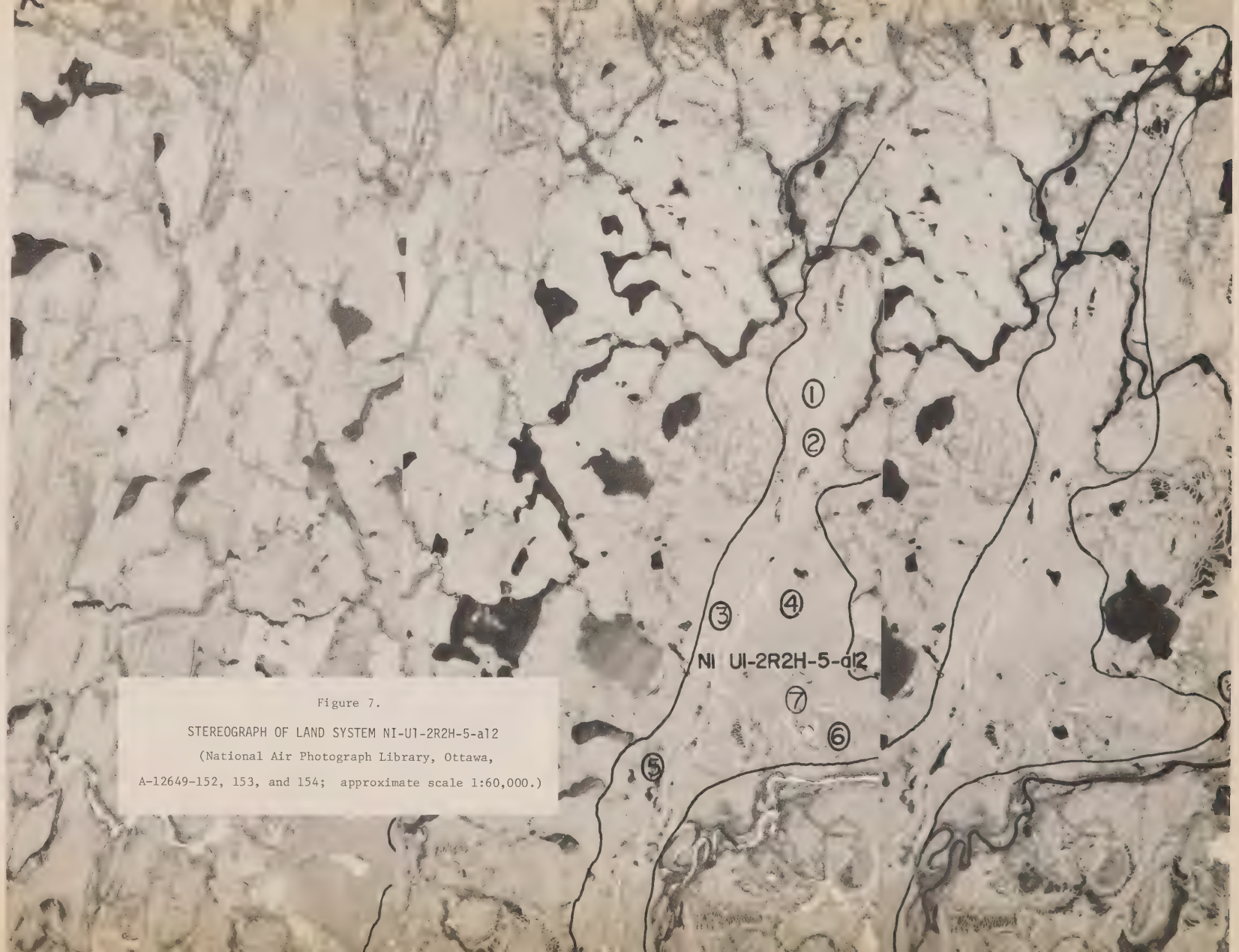

Figure 7.

STEREOGRAPH OF LAND SYSTEM NI-U1-2R2H-5-a12

(National Air Photograph Library, Ottawa,

A-12649-152, 153, and 154; approximate scale 1:60,000.)

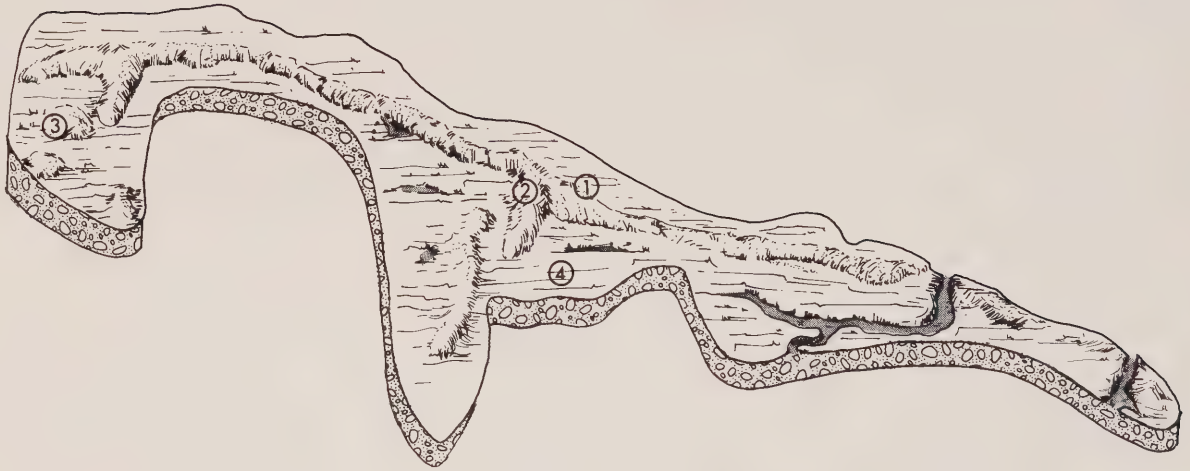

Figure 8 Block diagram of land system NI-U1-2R2H-5-a12
(The numbers in fig. 7 and 8 refer to the land types listed on the card shown in fig. 9)

Reconnaissance n°	Photo n°	LAND SYSTEM	Terrestrial portion
285	23D#436,437,506;507		NI-U1-2R2H-5
JBTE PROJECT			Aquatic portion a12 b12-2118-2 c12-2118-2 f12-3128-2 n12-3128-2 h12-1142-24*

Land type						
Provisional	Final	Landform	Drainage	Percentage	Soils	Vegetation
1 SG1		2ag	1	5		
2 SG23		2ag	23	5		
3 SM23		2am	23	35		
4 SM23		2bm	23	40		
5 TV6		7b/2bm	6	5		
6 FVN6*		7*n/2bm	6*	5		
7 DU1		9a	1	5		

Figure 9 Descriptive card for land system

Example 3 (figs. 10 and 11)

OT-M9-0-a11
g11

This land system is located in Otish Mountains (OT) land region; its relief is mountainous (M), with a predominance of rocky outcrops (9) and (0). It is the fourth of the M9-0 land systems. A part of the system has nos lakes or rivers (a), but another part has a large lake (g). There are very few streams and wetlands. The shoreline of the lake is irregular (2); the slope of the littoral shelf is moderate (2); the slope of the shore is steep and moderate (8); the lake is open and deep (1), with rocky shores (0) (fig. 12).

Figure 10.

STEREOGRAPH OF LAND SYSTEM OT-M9-0-4-all

(National Air Photograph Library, Ottawa, A-12469-140, 141, and 142; approximate scale 1:60,000.)

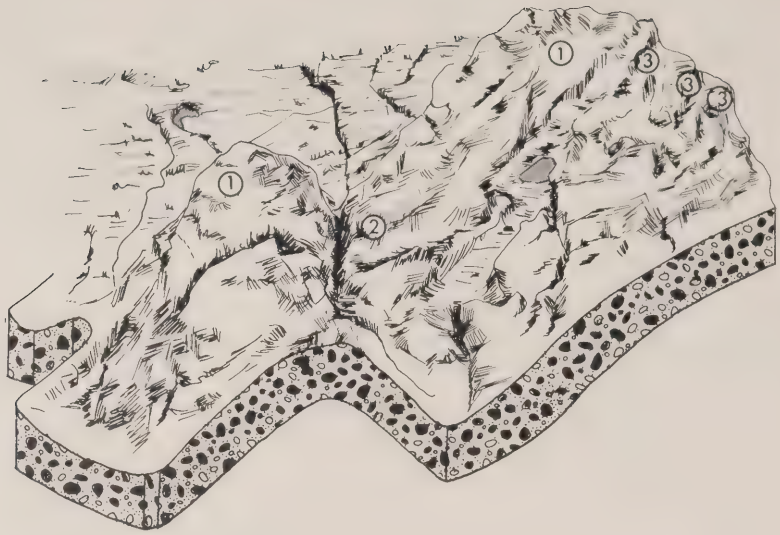

Figure 11 Block diagram of land system OT-M9-0-4-a11

(The numbers in figs.10 and 11 refer to the land types listed on card shown in fig. 12).

Reconnaissance nº	Photo nº	LAND SYSTEM	Terrestrial portion
262, 263, 285, 287	23D#505,506,507,513, 514,515,599,600, 601,641,642		OT-M9-0-4
JBTE PROJECT			Aquatic portion a11 g11-2281-0

Land type						
Provisional	Final	Landform	Drainage	Percentage	Soils	Vegetation
1 R01		R	1	80		
2 RT14		R1	14	10		
3 TR34*		1a-R	34*	10		

Figure 12 Descriptive card for land system

Photointerpretation of land systems

The mapping of the land systems of the James Bay Territory was based entirely on interpretation of panchromatic black and white small-scale aerial photographs (1:40,000 or 1:60,000 depending on coverage). The photointerpretation was done by a team of six to eight photointerpreters supervised by a co-ordinator who ensured that interpretations were uniform and consistent.

Delimitation of land systems

To delimit a land system is basically to identify a particular geographical framework with its associated pattern of land types. In practice, this means drawing a line following the major divisions (geomorphological or biological or both) of the natural environment that are visible on the aerial photograph. The lines drawn by the photointerpreter between two neighbouring land systems will usually be those of greatest contrast, that is, the boundaries of different divisions. In this procedure the concept of *a priori* integration is vital. In the following chapter we will try to illustrate this concept with detailed examples.

Chapter Three

ANNOTATED STEREOGRAPHS

Here we present a set of stereographs to illustrate a number of land systems in the James Bay Territory. Each one will be accompanied by a detail of the ecological map, situating it in a more general context.

Stereograph 1

OP-M6-1VO-56-a11

Surficial deposits in this area very homogeneous; the boundary of the system represents a sharp division in relief. The relief of neighbouring land systems is much less steep (fig.13).

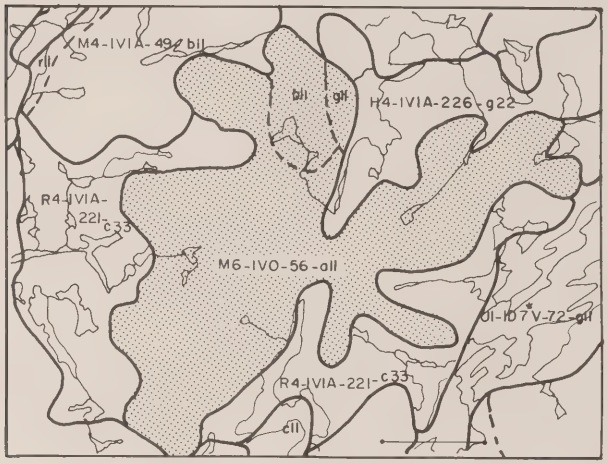

Figure 13 Map of land system OP-M6-1VO-56-a11
(Detail of ecological map 23F/NE; scale 1:125,000)

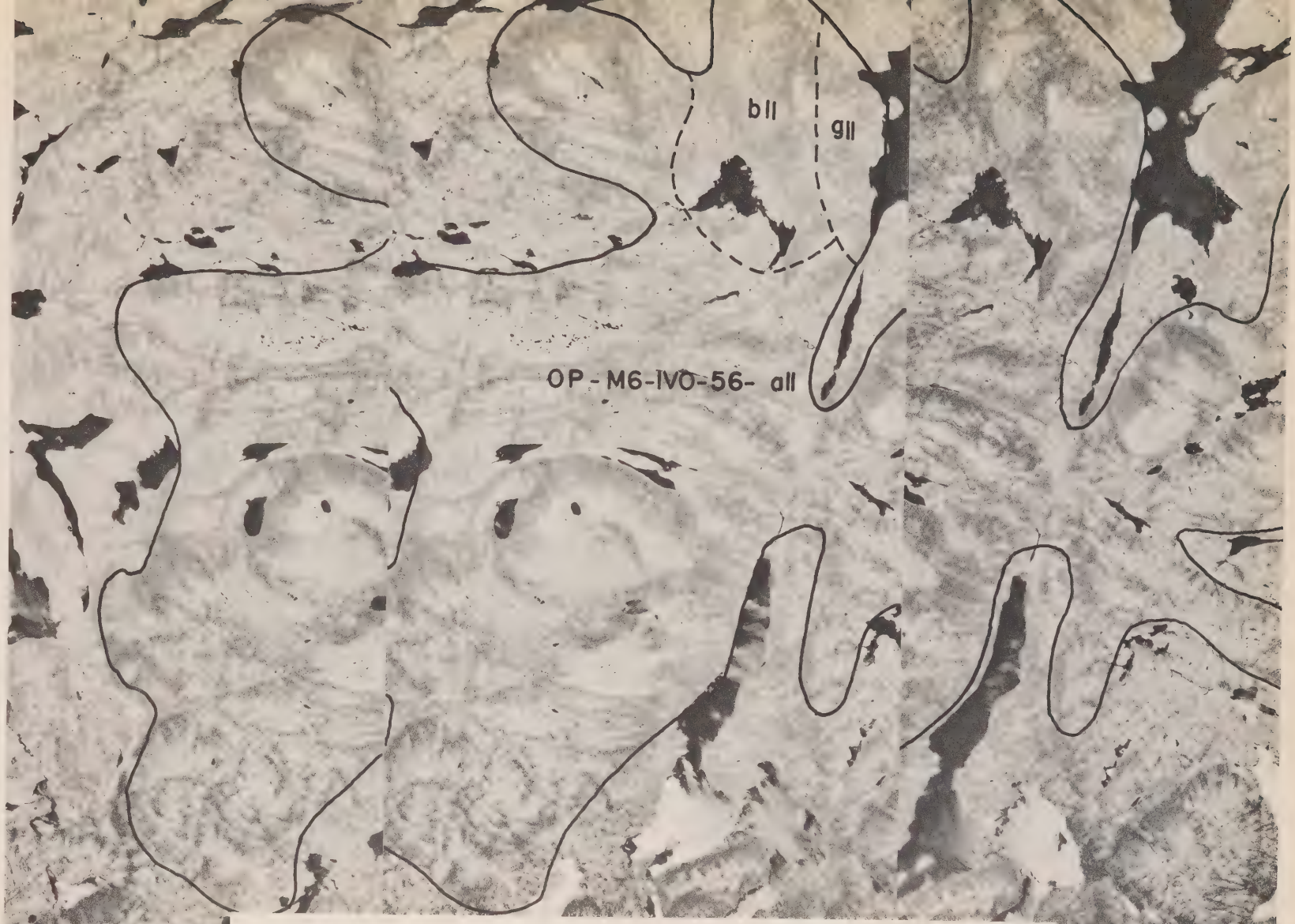

Figure 14.

MOUNTAINOUS LAND UNIT IN THE OPISCOTEO LAKE REGION,
WITH A PREDOMINANCE OF THIN TILL AND ROCKY OUTCROPS: OP-M6-1V0-56-a11
(National Air Photograph Library, Ottawa, A-21577-126, 127, and 128; approximate scale 1:60,000.)

Stereograph 2

MA-M9-0*-1-a11

The distinctive features of this land system are:

(1) Abrupt change in slope: very steep, nearly vertical slopes, giving way to relatively gentle but very long slopes (mountainous (M) relief on front face of cuesta *vs.* hilly (H) relief on back face).

(2) Again, abrupt change in slope, here accompanied by a clear division in the type of surface deposits: bedrock outcrops and talus, suddenly giving way to eroded marine clay.

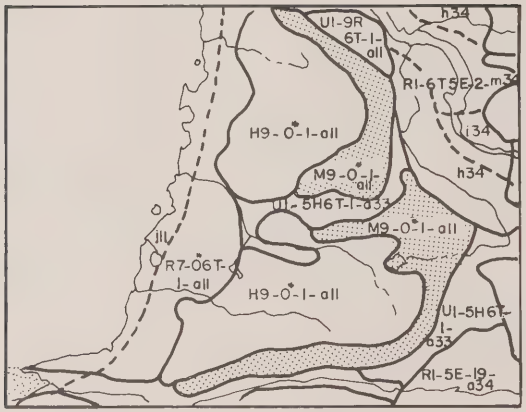

Figure 15 Map of land system MA-M9-0*-1-a11
(Detail of ecological map 33N/NE; scale 1:125,000)

Figure 16.

MOUNTAINOUS LAND UNIT IN MANITOUNUK REGION, WITH A PREDOMINANCE OF OUTCROPS: MA-M9-0*-1-all

(National Air Photograph Library, Ottawa, A-15613-107, 108, and 109; approximate scale 1:60,000.)

Stereograph 3

SA-U1-6T-1-a11

This land system has a very distinct boundary, marked by three divisions. On one side, there are terraced sandy deposits (1); on the other, numerous organic deposits (2). This geomorphological division is accompanied by a marked change in vegetation cover: the sandy terraces are covered with trees, while grasses or shrubs or both cover the peat bogs. There is also a complete absence of streams in the system under consideration (1), while in the systems with a predominance of peat (2), streams are more numerous.

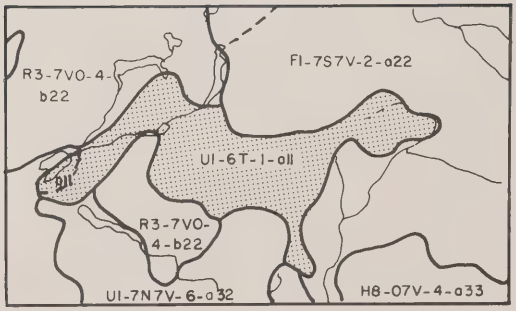

Figure 17 Map of land system SA-U1-6T-1-a11
(Detail of ecological map 33C/NW; scale 1:125,000)

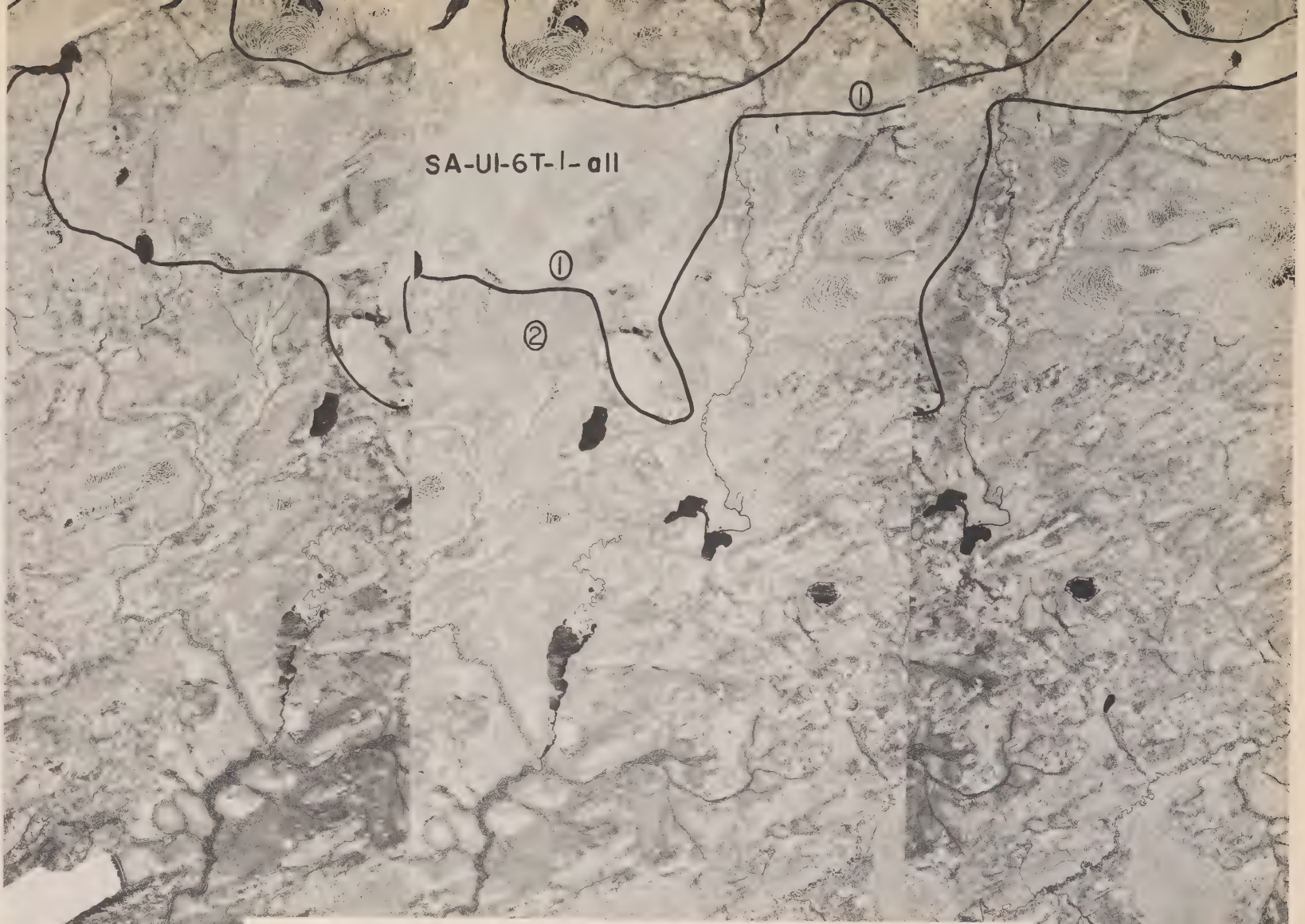

Figure 18.

RAISED BEACHES IN THE SAKAMI LAKE REGION: SA-U1-6T-1-a11

(National Air Photograph Library, Ottawa, A-15261-110, 111, and 112; approximate scale 1:60,000.)

Stereograph 4

KA-U1-4*T7V-6-i33

The main contrast between this land system and adjoining ones is a major difference in the type of surface deposit:

① Sandy terraces vs. thin bogs.

② Sandy terraces vs. marine clay.

③ Sandy terraces vs. bedrock outcrops. In this case, there is also a difference in relief.

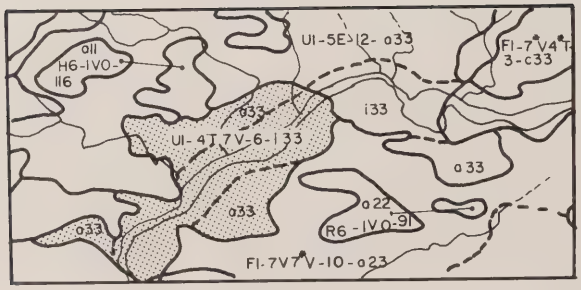

Figure 19 Map of land system KA-U1-4*T7V-6-i33
(Detail of ecological map 33K/SE; scale 1:125,000)

Figure 20.

FLUVIATILE TERRACES OF THE KANAAUPSCOW RIVER INTERSPERSED WITH THIN BOGS: KA-UI-4*T7V-6-i33

(National Air Photograph Library, Ottawa, A-14293-134, 135, and 136; approximate scale 1:60,000.)

Stereograph 5

BI-U1-9R6T-1-all

This land system stands out clearly from the surrounding landscape, as there is a striking contrast between the sandy dunes and terraces, (1) and (2), and the eroded marine clay (3) that surrounds it. This contrast is emphasized further by a difference in relief.

Also note that there are no streams and wetlands in this system unlike in the surrounding land systems (fig. 21).

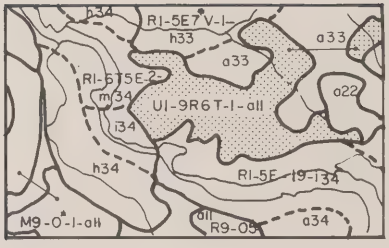

Figure 21 Map of land system BI-U1-9R6T-1-all
(Detail of ecological map 33N/NE; scale 1:125,000)

Figure 22.

RAISED BEACHES NEAR THE MOUTH OF THE GREAT WHALE RIVER,
PARTIALLY RESHAPED INTO DUNES BY THE WIND: 31-U1-9R6T-1-a11

(National Air Photograph Library, Ottawa, A-15613-5, 6, and 7; approximate scale 1:60,000.)

Stereograph 6

MT-H7-04*A-1-all

This land system (the Hedge Hills) contrasts strongly with the plain of lacustrine sediment (Lake Barlow-Ojibway) that surrounds it. This contrast is mainly due to:

* a marked division in relief, which is undulating (U) in the plain, but suddenly becomes hilly (H) (fig. 23).
* a marked break in the type of surface deposit: clay silt sediments in the lacustrine plain (1) vs. a rocky substratum and sandy lacustrine sediments in the Hedge Hills (2).
* few streams and wetlands in the hills (2), but numerous streams and wetlands in the plain (3) (fig. 23).

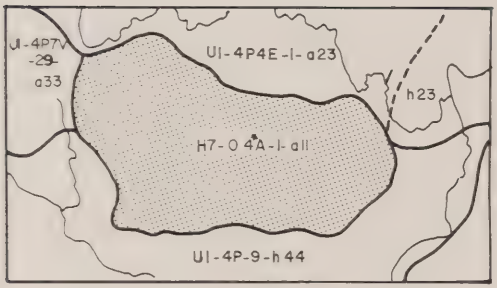

Figure 23 Map of land system MT-H7-04*A-1-all
(Detail of ecological map 32E/SE; scale 1:125,000)

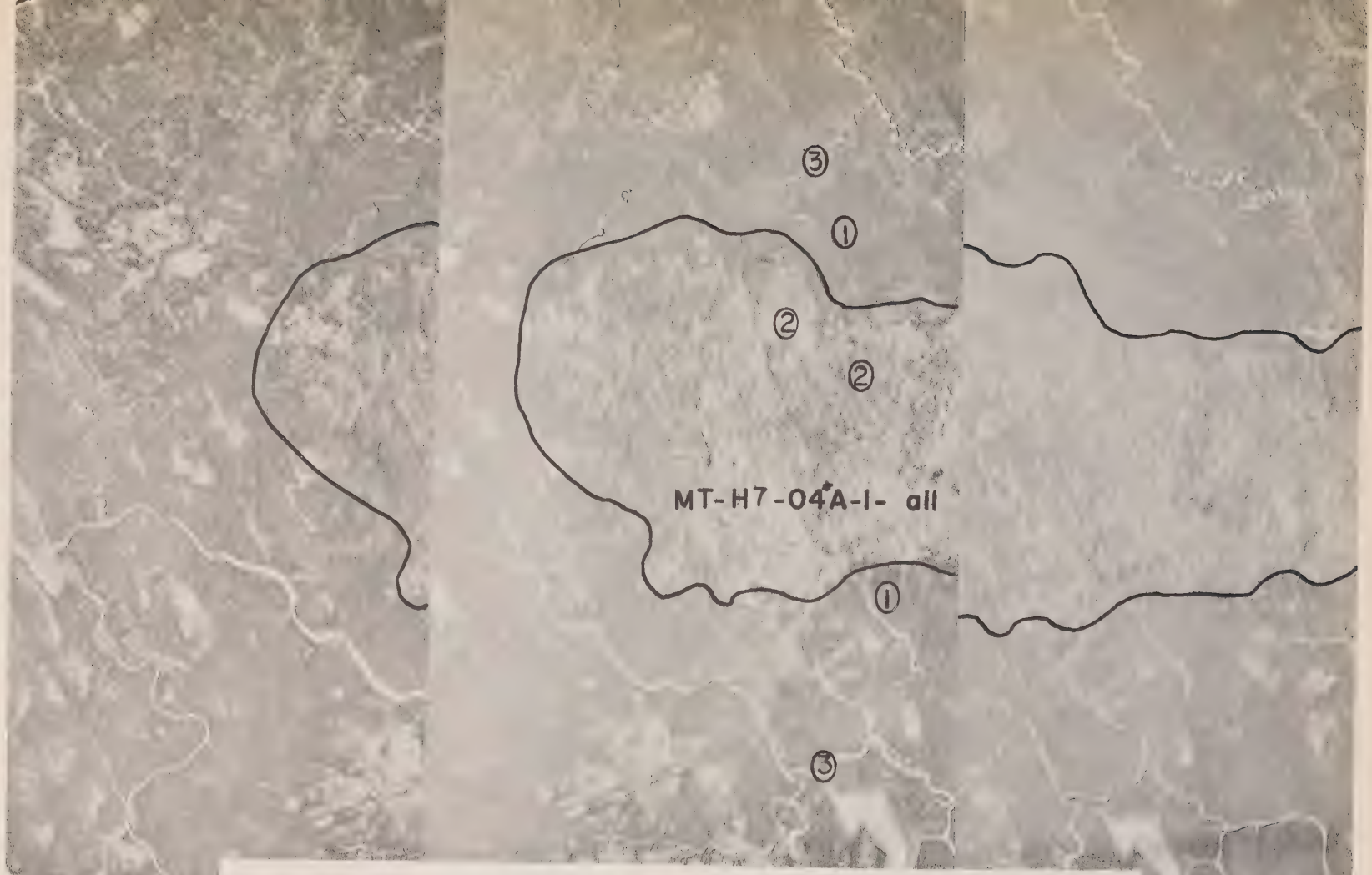

Figure 24.

HILLS OF ROCK AND SANDY LACUSTRINE DEPOSITS IN THE LAKE MATAGAMI REGION (HEDGE HILLS): MT-H7-04*A-1-all

(National Air Photograph Library, Ottawa, A-13606, 63, 64, and 65; approximate scale 1:60,000.)

Stereograph 7

MT-F1-7N-17-a11

This example is unusual because the entire length of the boundary of the land system is marked by three divisions:

* first, the bog is flat (F), while the surrounding land systems are undulating (U) (fig. 25).
* system (1) has a thick peat deposit, but is surrounded by lacustrine clay silt sediments (2).
* the bog (1) is covered by grass or shrub or both, while the lacustrine sediment (2) is covered by trees.
* there is a total absence of watercourse in the bog, but they are numerous in the lacustrine sediment (3) (fig. 25).

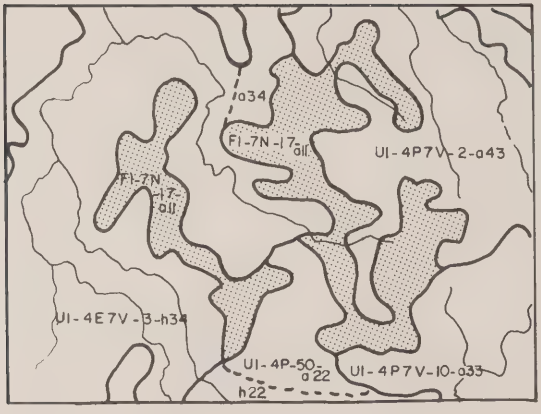

Figure 25 Map of land system MT-F1-7N-17-a11
(Detail of ecological map 23E/SW, scale 1:125,000)

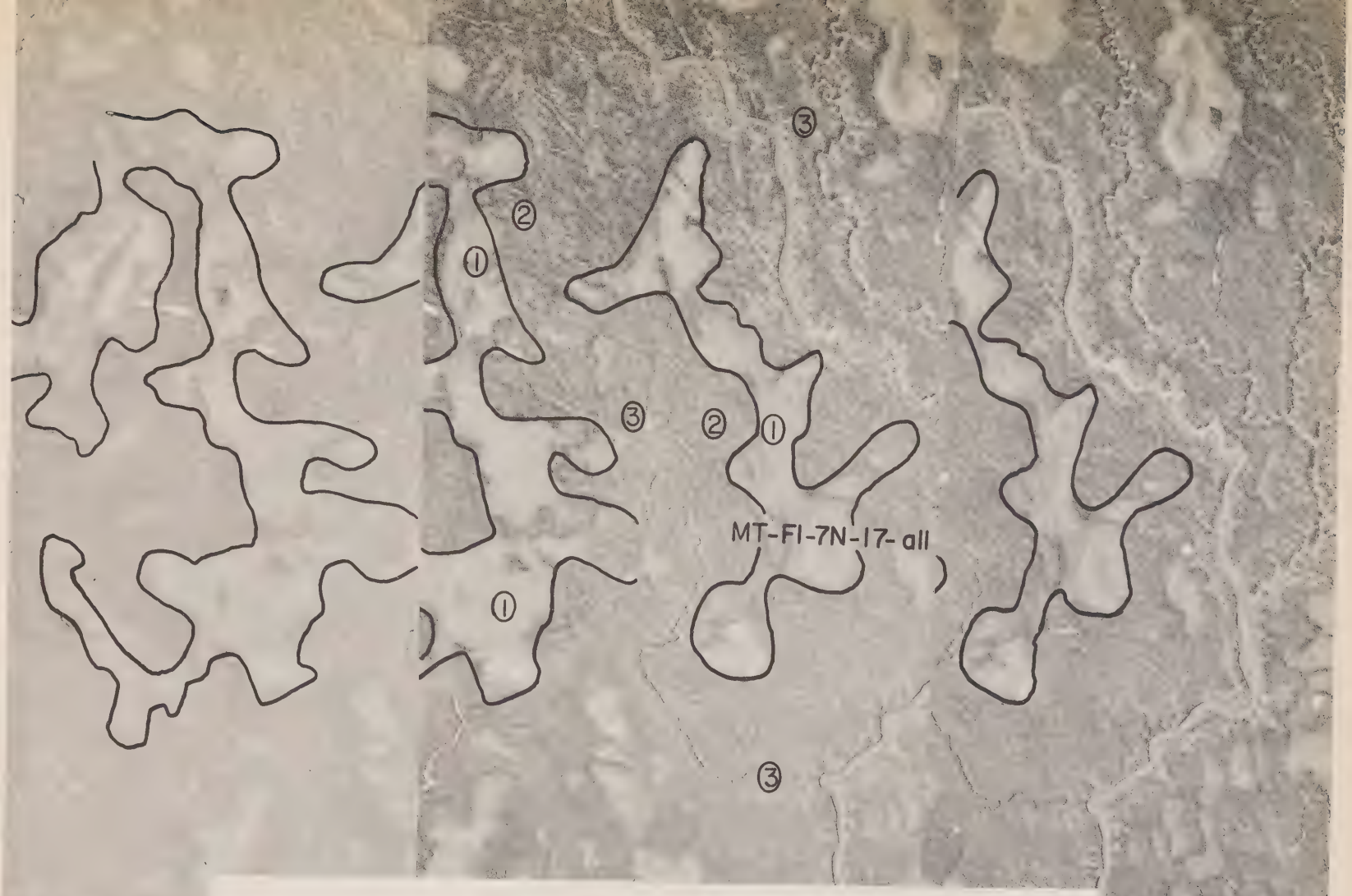

Figure 26.

DEEP BOG IN THE LAKE MATAGAMI REGION MT-F1-7N-17-all

(National Air Photograph Library, Ottawa, A-13378-19, 20, and 21; approximate scale 1:60,000.)

Stereograph 8

MT-F1-7V1*P-3-a33

The distinctive features of this system are more or less the same as those of the preceding one:

* slight difference in relief (fig. 27); the system is flat (F), while the surrounding systems are undulating (U);
* a very clear division in the type of surficial deposits, passing from a strong predominance of thin bog to a strong predominace of silty Cochrane till (1);
* this division is emphasized by a clear difference in the type of vegetation cover: grass and shrubs or both in the system under consideration, and forest in the surrounding systems.

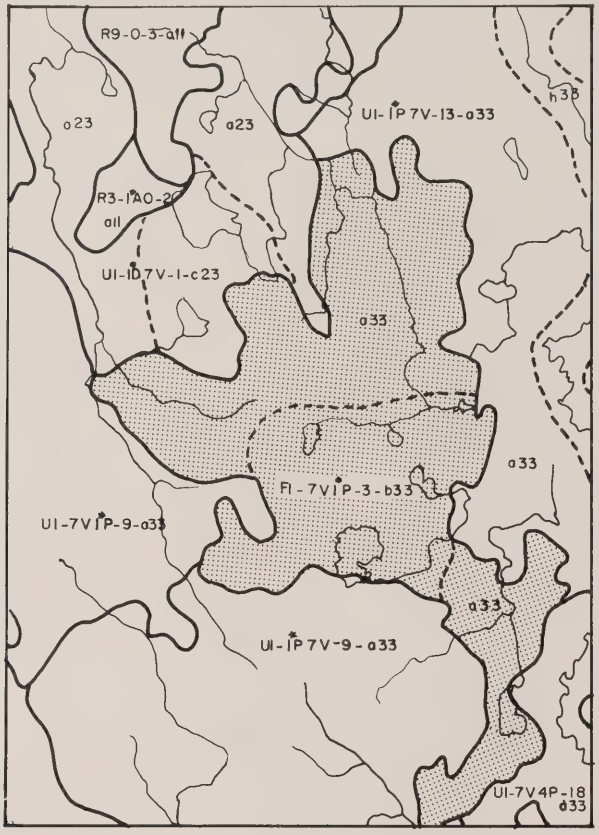

Figure 27 Map of land system MT-F1-7V1*P-3-a33
(Detail of ecological map 32E/NE; scale 1:125,000)

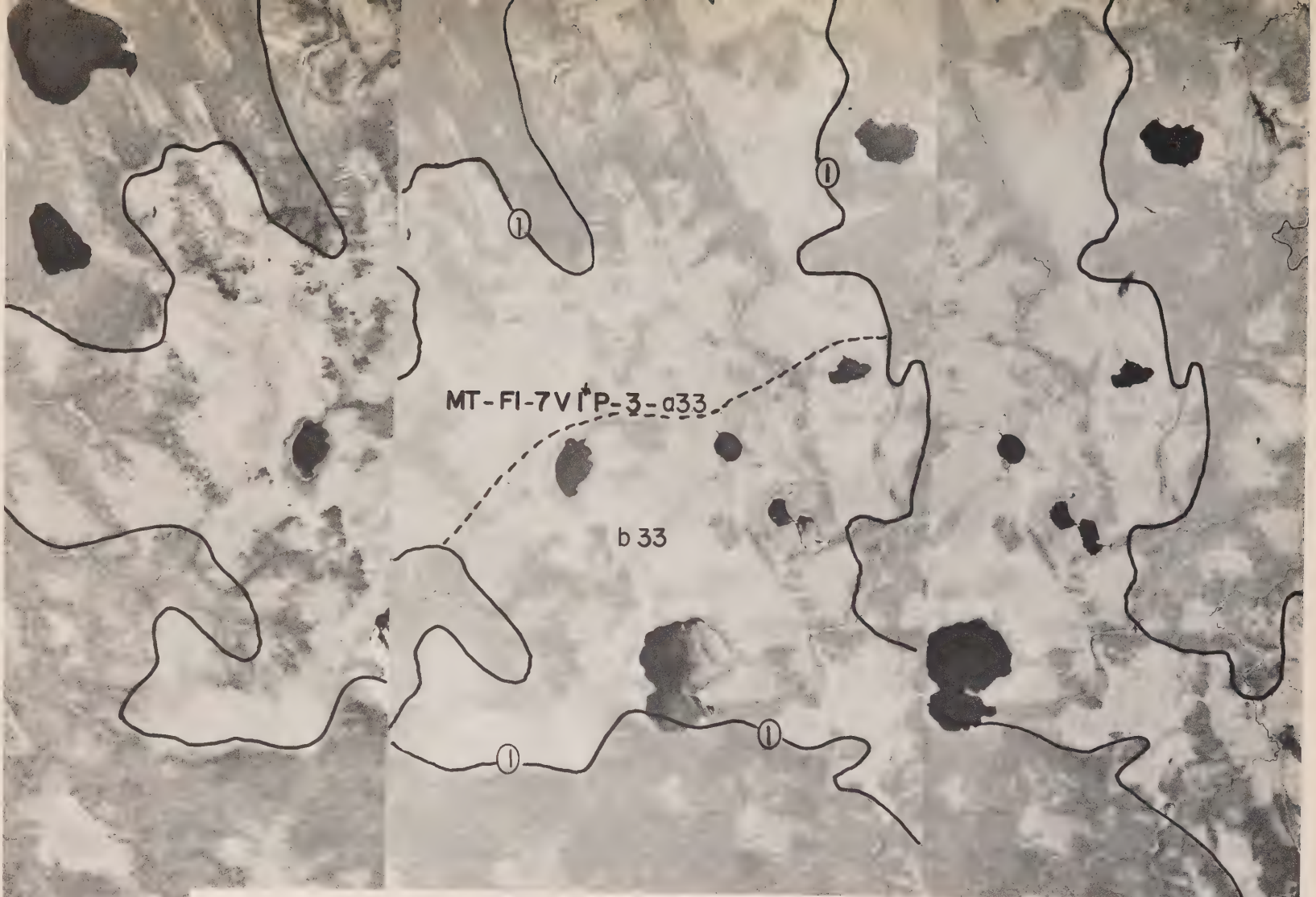

Figure 28.

MIX OF THIN BOGS AND COCHRANE TILL: MT-F1-7V1*P-3-a33

(National Air Photograph Library, Ottawa, A-13606-122, and 124; approximate scale 1:60,000.)

Stereograph 9

DE-U1-7*V7V-2-g11

This system has several distinctive features, but unlike the previous examples, the boundary is defined by different features at different points.

The sharpest division is in the type of surface deposits: thin fens and bogs vs. till (1); this is further emphasized by an abrupt change in the type of vegetation cover (1) (grass or shrubs or both vs. forest). At some points there is also a change in relief (2): the system is undulating (U), but to the northeast, the relief is rolling (R) or hilly (H) (fig. 29).

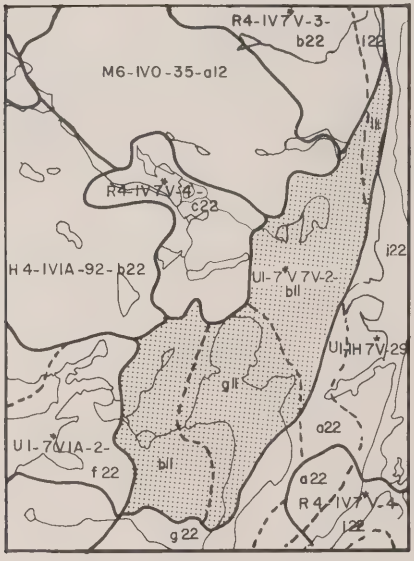

Figure 29 Map of land system DE-U1-7*V7V-2-g11
(Detail of ecological map 23K/NW; scale 1:125,000)

Figure 30.

MIX OF THIN FENS AND THIN BOGS IN THE LAKE DELORME REGION: DE-U1-7*V7V-2-g11

(National Air Photograph Library, Ottawa, A-23593-131, 132, and 133; approximate scale 1:60,000.)

Stereograph 10

KA-U1-7H7*V-1-a23

Here again the boundary is characterized by different features at different points:

* the type and morphology of surficial deposits; peat vs. terraced littoral deposits (1);
* the morphology of surficial deposits; palsas vs. thin peat (2);
* the type of surface deposits; thin peat or palsas (3) or both vs. sandy littoral veneer on rock (4);
* the relief changes from undulating (U) to rolling (R) northwest of the system (4), where there are thin deposits (fig. 31).

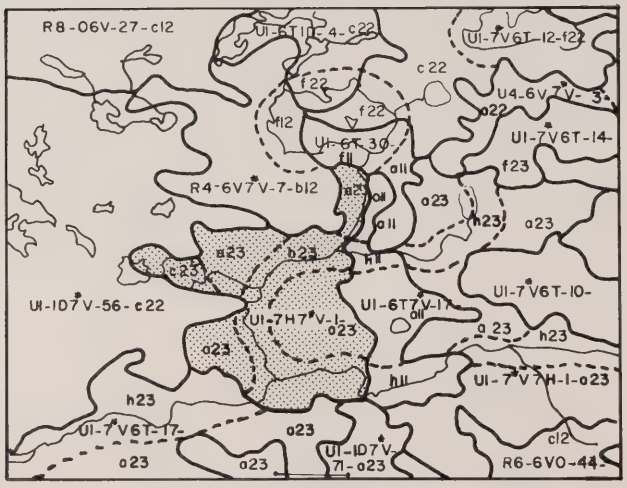

Figure 31 Map of land system KA-U1-7H7*V-1-a23
(Detail of ecological map 33N/SW; scale 1:125,000)

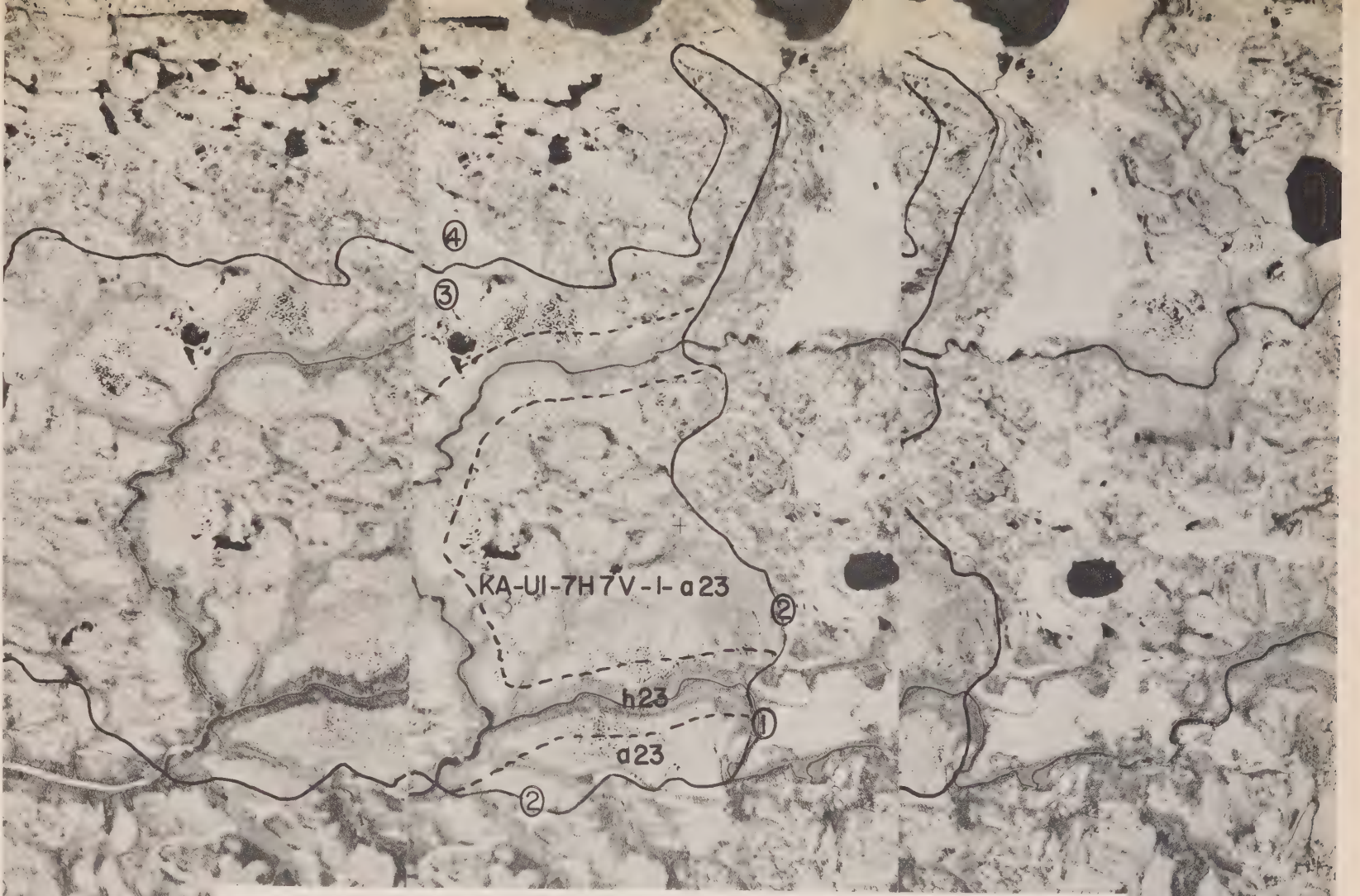

Figure 32.

PALSA FIELD SURROUNDED BY THIN FENS IN THE KANAAUPSCOW RIVER REGION: KA-U1-7H7*V-1-a23

(National Air Photograph Library, Ottawa, A-13342-68, 69, and 70; approximate scale 1:60,000.)

Stereograph 11

MI-U1-1AE-6-b21

Again, different features at different points define the boundary:

① A change in relief, from undulating (U) to flat (F) and a change in the type of surficial deposits: till vs. thin peat (fig. 33).

② A change in relief, undulating (U) vs. rolling (R), accompanied by a change in thickness of surficial deposits (thick vs. a combination of thick and thin).

③ The relief changes from undulating (U) to mountainous (M) and thick deposits give way to a combination of thick and thin ones (fig. 33, southwest portion).

④ The type of surficial deposit all along the river is significant, passing from till to sandy fluviatile alluvia.

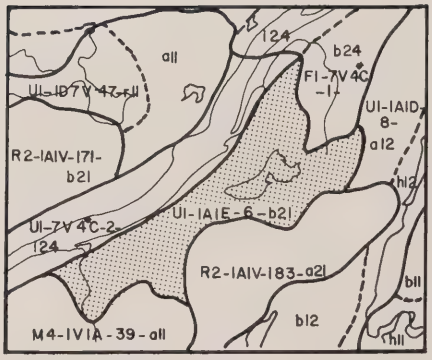

Figure 33 Map of land system MI-U1-1A1E-6-b21 (Detail of ecological map 32P/SE; approximate scale 1:125,000).

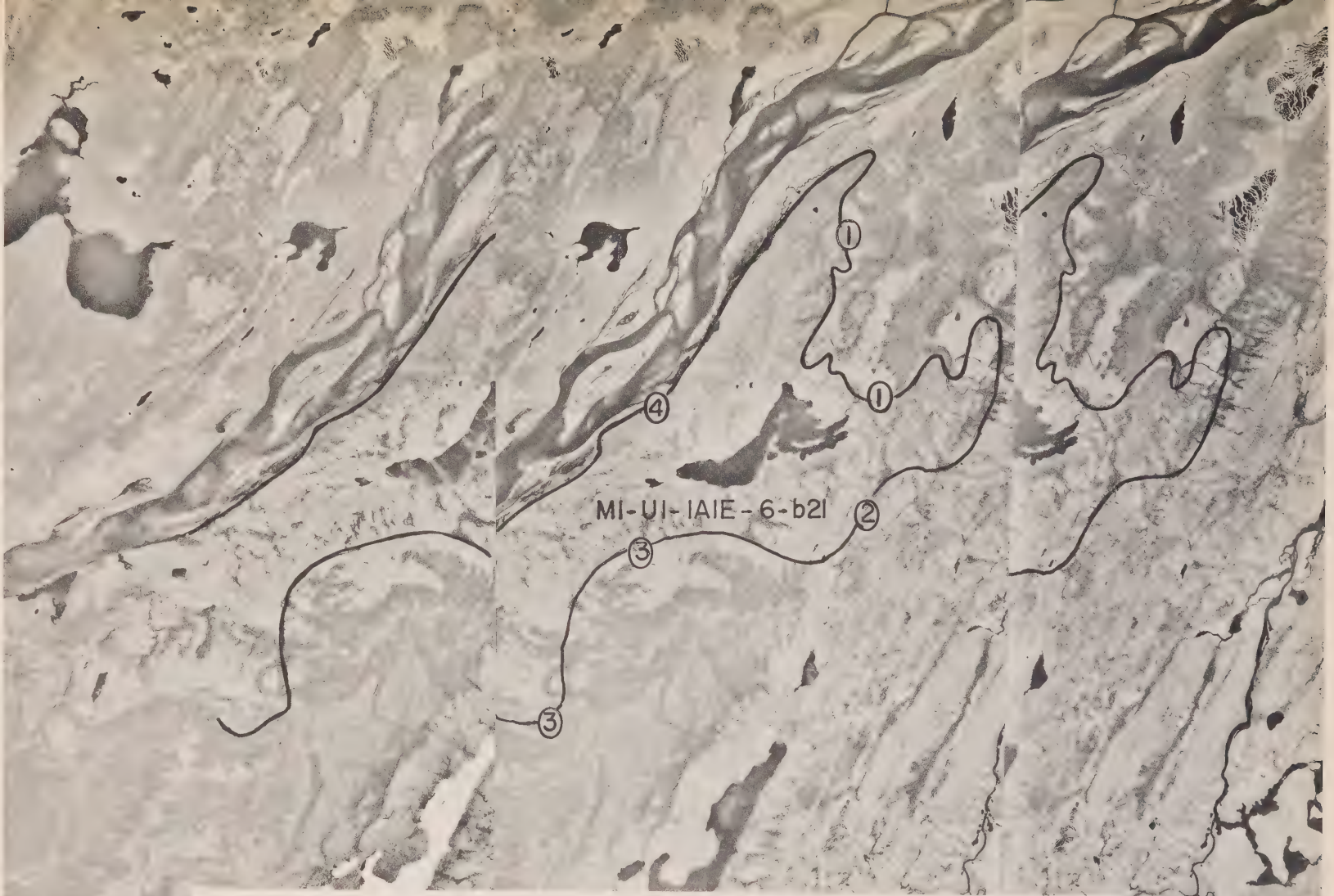

Figure 34.

UNDULATING LANDSCAPE IN LOCALLY ERODED THICK TILL IN THE LAKE MISTASSINI REGION: MI-U1-1A1E-6-b21

(National Air Photograph Library, Ottawa, A-15432-121, 122, and 123; approximate scale 1:60,000.)

Stereograph 12

NI-U1-1D7V-38-b22

The notion of pattern is especially relevant in the mapping of this land system. There is no major division constituting its boundaries, as there was in the previous examples. However, within this unit of thick till in the form of undulating drumlins (fig. 35) there is a particular pattern of land types, further emphasized by a change in vegetation cover: depressions between the drumlins are occupied by thin bogs covered with grasses or shrubs or both (1); the drumlins are covered by very open forest with lichens (2) on well-drained hilltops and by very open forests with mosses or sphagnums or both (3) at the base of less well-drained slopes.

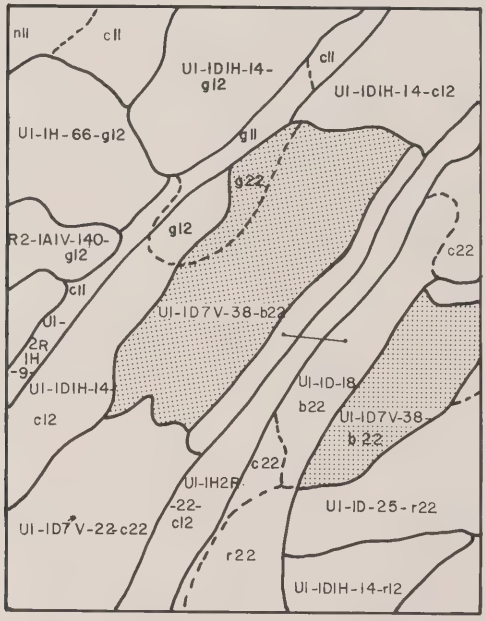

Figure 35 Map of land system NI-U1-1D7V-38-b22
(Detail of ecological map 23D/NW; scale 1:125,000)

Figure 36.

DRUMLIN FIELD INTERSPERSED WITH THIN BOGS IN THE LAKE NICHICUN REGION: NI-U1-1D7V-38-b22

(National Air Photograph Library, Ottawa, A-12963-178, 179, and 180; approximate scale 1:60,000.)

CONCLUSION

A priori integration

The detailed examples show clearly that in interpreting the aerial photographs, a number of significant variables are taken into account simultaneously in order to represent the variety of the natural environment. This is the a priori integration approach, which leads the photointerpreter to distinguish homogeneous land units (land systems) in terms of a set of preselected ecological variables. Each land system can be evaluated in terms of capability or risk of degradation, on the basis of its constituent elements (land types, waterbodies and their morphometric characteristics). The land systems can then be classified, making it possible to determine rapidly for what major uses the land is naturally suited.

Aquatic portion of land systems

An examination of the examples we have given shows very clearly that the criteria related to the terrestrial portion predominated in defining the system; with few exceptions, aquatic criteria played no part. In other words, the aquatic dimension is still not considered in the process of a priori integration. We merely added the aquatic information after the land system had been delimited by terrestrial criteria, since at the beginning of the JBTE project, a priori integration of the aquatic information still raised too many methodological problems.

The various categories of waterbodies are shown on the ecological map by a dotted line, which is merely a convenient mapping device. The area within the dotted line is an integral part of the land system, not a subdivision indicating a special zone related to the proximity of the waterbody.

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Appendix 1

LEGEND FOR THE JAMES BAY TERRITORY ECOLOGICAL MAP

Land Regions (Ducruc et al., 1976)

CH: Chibougamau Lake
MT: Lake Matagami
OT: Otish Mountains
HI: Lake Hippocampe
MI: Lake Mistassini
EV: Evans Lake
RU: Rupert's Bay
OP: Opiscoteo Lake
NI: Nichicun Lake
SA: Sakami Lake
FG: Fort George
LE: Lake Le Grand
KA: Kanaupscow River
RO: Roggan River
SC: Schefferville Mountains
DE: Lake Delorme
BI: Lake Bienville
MA: Manitounuk
LO: Pointe Louis XIV

Relief (Jurdant et al., 1977)

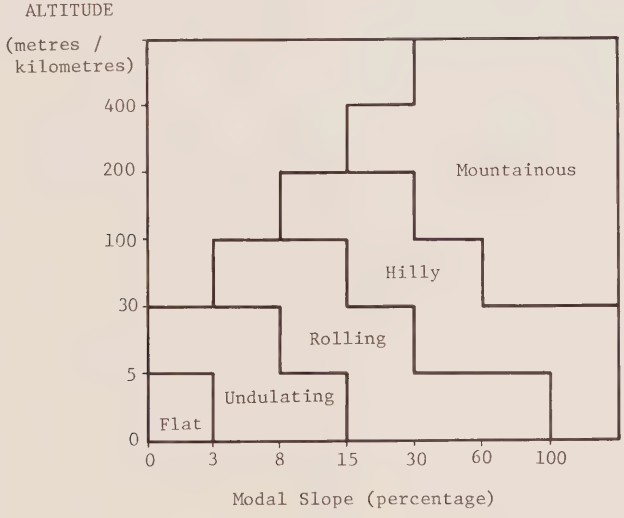

Figure 37 Relief classes

THICKNESS OF SURFICIAL GEOLOGICAL MATERIAL

1: thick
2: thick and thin
3: thick and outcrops
4: thin and thick
5: thin
6: thin and outcrops
7: outcrops and thick
8: outcrops and thin
9: outcrops

SURFICIAL GEOLOGICAL MATERIAL

Type and origin

1: till
1*: Cochrane till
2: fluvioglacial sediments
4: glaciolacustrine clay silt sediments
4*: sandy glaciolacustrine fluviatile sediments
5: marine clay sediments
6: littoral sediments
7: organic sediment (bog)
7*: organic sediment (fen)
8: slope deposits
9: wind deposits
0: bedrock

Morphology

A: bedrock-controlled
D: drumlinoid
E: eroded
H: hummocky
L: talus
N: non-structured organic deposits
P: plains
R: ridges
S: structured organic deposits
T: terraced
V: veneer
*: cuestas (in bedrock)

Aquatic ecosystem categories

a: less than 5% of the area of the ecological system is covered by water
b: 5-15% of the area is covered by lakes of less than 250 ha
c: more than 15% of the area is covered by lakes of less than 250 ha
f: the land system includes or borders on lakes between 250 and 500 ha
g: the land system includes or borders on lakes between 500 and 1000 ha
n: the land system includes or borders on lakes between 1000 and 2500 ha
r: the land system includes or borders on lakes of more than 2500 ha
h: the land system borders on small rivers of an average width from 20-60 m
i: the land system borders on large rivers of an average width greater than 60 m
m: the land system borders on parts of rivers affected by tides
J: the land system borders on James Bay and Hudson Bay

Number of streams and wetlands

1: none or very few
2: few
3: average number
4: numerous
5: extremely numerous

Morphometry of water bodies

Lakes

Irregularity of shoreline

1: regular
2: irregular
3: very irregular

Slope of littoral shelf

1: gentle
2: moderate
3: steep

Rivers

Form of banks

1: sinuous
2: meandering
3: braided

Presence of rapids

1: none
2: few
3: many

Lakes and rivers

Slope of banks

1: gentle
2: gentle and moderate
3: gentle and steep
4: moderate and gentle
5: moderate
6: moderate and steep
7: steep and gentle
8: steep and moderate
9: steep

Drainage system and depth

1: open and deep
2: open and shallow
3: open and peaty
4: limited and deep
5: limited and shallow
6: limited and peaty
7: closed and deep
8: closed and shallow
9: closed and peaty

Type of geological material in bank surfaces

See "Surficial geological material".

Appendix 2

ECOLOGICAL MAPS OF THE JAMES BAY TERRITORY
(1:125,000 SCALE MAPS OF LAND SYSTEMS)

Index of maps of the James Bay Territory

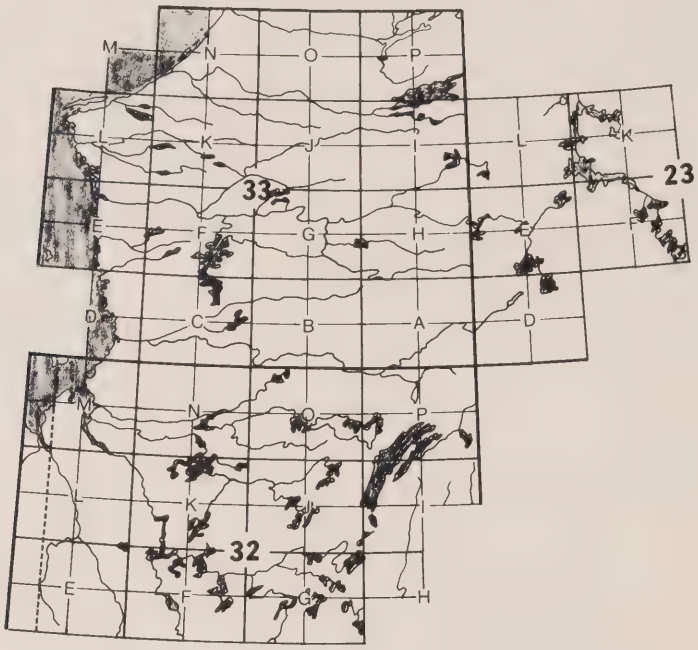

Figure 38 Index of 1:125,000 scale maps of the James Bay Territory

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33B/N.-E. J.P. Ducruc D. Bérubé J.L. Bélair G. Gilbert	33B/N.-O. R. Wells P. Dorais J.L. Bélair G. Gilbert	33B/S.-E. J.P. Ducruc D. Bérubé J.L. Bélair G. Déry	33B/S.-O. J.M. Mondoux J.L. Bélair G. Gilbert
33C/N.-E. J.P. Ducruc D. Bérubé J.L. Bélair G. Gilbert	33C/N.-O. J.P. Ducruc D. Bérubé J.L. Bélair G. Gilbert	33C/S.-E. R. Zarnovican G. Grenier J.L. Bélair G. Gilbert	33C/S.-O. R. Zarnovican G. Grenier J.L. Bélair G. Gilbert
33D/N.-E. J.P. Ducruc D. Bérubé J.L. Bélair G. Gilbert	33D/N.-O. -	33D/S.-E. J.P. Ducruc D. Bérubé J.L. Bélair G. Gilbert	33D/S.-O. -
33E/N.-E. A. Guimond J.L. Bélair M. Jurdant	33E/N.-O. Gauthier, Poulin, Thériault et associés	33E/S.-E. Gauthier, Poulin, Thériault et associés	33E/S.-O. Gauthier, Poulin, Thériault et associés
33F/N.-E. Gauthier, Poulin, Thériault et associés	33F/N.-O. Gauthier, Poulin, Thériault et associés	33F/S.-E. Gauthier, Poulin, Thériault et associés	33F/S.-O. Gauthier, Poulin, Thériault et associés
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33I/N.-E.	R. Zarnovican J.P. Ducruc G. Gilbert	33I/N.-O.	R. Zarnovican J.P. Ducruc G. Gilbert	33I/S.-E.	D. Bérubé J.P. Ducruc G. Gilbert	33I/S.-O.	D. Bérubé J.P. Ducruc G. Gilbert
33J/N.-E.	C. Grenier J.P. Ducruc G. Gilbert	33J/N.-O.	C. Grenier J.P. Ducruc G. Gilbert	33J/S.-E.	L.D. Brown J.P. Ducruc G. Gilbert	33J/S.-O.	L.D. Brown J.P. Ducruc G. Gilbert
33K/N.-E.	C. Grenier J.P. Ducruc G. Gilbert	33K/N.-O.	C. Grenier J.P. Ducruc G. Gilbert	33K/S.-E.	L.D. Brown J.P. Ducruc G. Gilbert	33K/S.-O.	L.D. Brown J.P. Ducruc G. Gilbert
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James Bay Development Corporation